forest insects research priorities in the northeast

a report prepared for the north-eastern regional planning committee

northeastern forestry committee

forest insects subcommittee

RP 2.03

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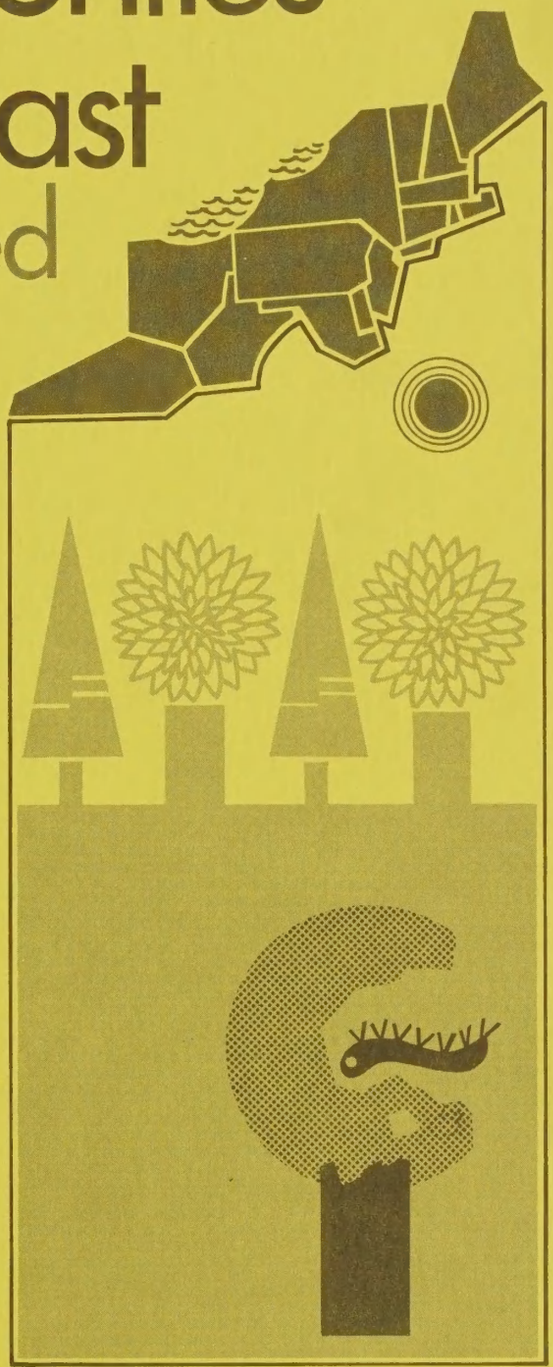

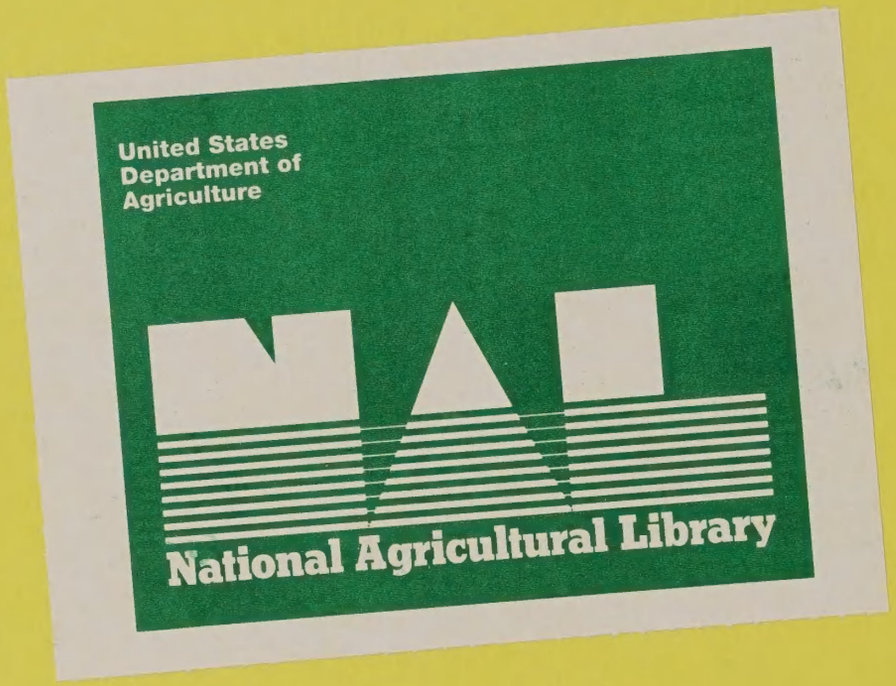
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PREFACE

This research planning report was prepared as part of the Regional and National Agricultural and Forestry Research Planning System. The mission of this System is:

1. To further the research effectiveness of scientific talent and other research resources and,

2. To improve coordination between Federal, state, and private research organizations.

Research planning reports were prepared for fifteen forestry research subject areas. The reports will help accomplish the mission of the Planning System by helping:

1. to guide forestry research to the highest priority needs;

2. to avoid duplication of research efforts;

3. to coordinate research findings and to build on interim research results;

4. to assure recognition of emerging problems;

5. to provide advance information for adjusting research capability to research needs.

The subjects of the fifteen reports are:

2.01 Forest Inventory
2.02 Timber Management
2.03 Forest Insects
2.03 Forest Diseases
2.03 Forest Fire
2.04 Timber Harvesting
2.04 Forest Products Marketing
2.04 Forest Products Utilization
2.05 Forest Soils
2.05 Forest & Water Relationships
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2.06 Wildlife & Fisheries Habitat
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2.08 Forest Land Use
2.09 Forest Economics, Policies, and Programs

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II. SUMMARY TABLE OF PROPOSED RESEARCH

	Titles	Degree of Difficulty	Study Term	Information		Personnel Needs	Research Beneficiary	Benefits		Risk		Priority
				Source	Adequacy			Direct	Indirect	Use	Objective	
A.	Management of pests of spruce fir forests	H	L	E,F,L	H	5	S,F,P,I,C	H	H	H	M	M
B.	Management of pests of hardwoods (defoliators, borers, and scales)											
	1. Management of pests of hardwoods-defoliators	H	L	E,F,L	M	8	S,F,P,I,C	H	H	H	M	H
	2. Management of pests of hardwoods-borers	H	L	E,F,L	M	5	S,F,P,I	H	M	H	M	H
C.	Management of pests of coniferous plantations	H	L	E,F,L	M	4	S,F,P,I,C	H	M	H	M	M
D.	Management of pests of cone, seed, and seedlings	M	L	E,F,L	M	3	S,F,P,I	M	M	H	M	L
E.	Management of pests of wood products	M	S	E,F,L	M	2	S,F,I,C	H	L	H	H	M
F.	Management of tree diseases transmitted by insect vectors	H	L	E,F,L	M	2	S,F,P,I,C	H	M	H	L	M

GUIDE TO SUMMARY TABLE OF PROPOSED RESEARCH

Title	Degree of Difficulty	Study Term	Information	Personnel Needs	Research Benefactor	Benefits	Risk	Priority
			Source/Adequacy			Direct/Indirect	Objectives/Use	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)

(a) Title of research need

(b) Degree of difficulty (an assessment by members of the research planning group) - designate High (H), Moderate (M), or Low (L).

High: complex, multi-objectives, multi-disciplinary requiring senior scientist direct, multi-person support and high operating budget.

Moderate: single objective, junior scientist supervision, moderate operating budget, one or two person support staff.

Low: single objective, junior scientist supervision, low operating budget.

(c) Study term: 5-year period or less is considered short term (s), anything greater is long term (L).

(d) Information needed: The research may be of the type which requires inventory and interpretation of existing data (E), field studies (F), laboratory studies (L), or any combination of these three. Use (O) for other if E, F, or L do not apply and explain (O) in a footnote. The adequacy of existing information can be shown as High (H), Medium (M), or Low(L).

(e) Personnel needs: Show number of Scientist Man Years (SMY's) required for the research (SMY's are an indicator of both cost and time requirements).

(f) Research Benefactor: Show whether the major recipient and user of the research is: other Scientists (S), Federal Agencies (F), Other Public Agencies (P), Industry (I), the Public (C), or some other group (O).

(g) Benefits:
Direct benefits are -
High (H) where the results have immediate impact, are direct, and require little further work and snythesis. Medium (M) benefit is obtained from solutions to problems of lower priority, perhaps with an impact to small segments of the audience. Additional work is required to gain broader application. Low (L) benefit accrues to lower priority items or items which are very restricted in use, perhaps parochial. They may be one of a series of studies and require additional work or may be exploratory in nature.

Indirect benefits can also be shown as -
High (H), Medium (M), or Low (L). Strength of indirect benefits is indicated by such things as the potential use of this research to solve other problems, or use of the results as part of a broader, multi-resource type of problem.

(h) Likelihood of Success:
Both elements of this item can be classified as High (H), Medium (M), or Low (L). Objectives refers to the probability of reaching the objectives of the research. Use refers to the extent and likelihood that the research results will in fact be used.

(i) Priority: This is an overall research priority rating based on evaluation of all other elements in this table. Again, the priority should be shown as High (H), Medium (M), and Low (L).

III. INTRODUCTION

Losses due to insects have a significant impact on the growth, development and utilization of forests and their products in the Northeast. This region provides much of the high quality hardwood lumber and a lesser amount of softwood pulp for the Nation. If timber needs are to be met in the future, a reduction in these losses would represent a significant means of increasing future timber supplies. Unfortunately, at present we have neither the technology nor the means to measure these losses or minimize their impact.

Our location in the Northeast is unique and results in forest uses and problems that are different than those of other regions. The forests and woodlands not only provide timber and watershed protection, but for the people of this densely populated region, they also provide for year-round recreation.

We believe that our research planning should be on insect problems of regional importance, rather than local ones, and in some cases, might even include problems of national significance. For the scope of our planning we considered important insects affecting forest and shade trees and wood products.

Within this framework we included insect vectored diseases of forest and shade trees. The disease aspects of these problems are presented in the Forest Diseases Report in this series. The following problem areas were examined:

1. Management of pests of spruce-fir forests.

2. Management of pests of hardwoods (defoliators, borers, and scales).

3. Management of pests of coniferous plantations.

4. Management of pests of cone, seed and seedlings.

5. Management of pests of wood products.

6. Management of insect vectored tree diseases.

IV. BROAD PROGRAM AREAS OF RESEARCH

A. Title: Management of pests of spruce-fir forests.

Objective: Reduce insect caused losses to this forest type.

Situation evaluation: The spruce budworm is transcontinental in distribution and thus of national importance. It ranks as probably the most destructive defoliating pest of the spruce-fir forests in the northeastern region. History tells us that budworm populations are cyclic although the recent insecticidal control programs may have caused a change in this normal cyclic behavior. Heavy defoliation for several years results in considerable tree mortality, high fire hazard and disrupted availability of raw material for wood utilizing industries. Lesser degrees of defoliation reduce growth rate and lower resistance to disease and insects. Regardless of the intensity of attack, management plans are upset. The productivity of this timber type is further reduced by the inability to salvage the dead and dying trees due to the inaccessibility of many of these stands and the large acreages involved. If salvage is delayed beyond five years, the effect of decay, rot, stains, and wood borers make the operation uneconomical.

Balsam fir has been practically eliminated from coastal Maine and northern Vermont as a commercial species because of another insect, the balsam woolly aphid. Salvage of older infestations is impractical because of the excessive taper and hard, brittle wood resulting from the insect attack.

The bulk of the research on these insects is currently being conducted in the West on related species or in eastern Canada (see 2.02 Timber Management Report).

Research approach: Much is known about these insects and hosts from past work in the United States and Canada. An interdisciplinary team should be formed to develop the technology for a pest management system for this forest type. The team would assemble this information, determine what is lacking, and synthesize a management scheme for dealing with these and other pests of this forest type. Computer simulation would be utilized to bring together information on the insects, hosts, meteorological factors, control options, etc., to specify a control strategy to maximize stand productivity. Envisioned in this technology would be techniques for gauging impact caused by these insects on the forest. For instance, remote sensing techniques could be used to monitor this forest type and provide up-to-date cost effective information on defoliated areas by degree category or areas affected. Sequential imagery would be a permanent record of the

pests' rate of spread or infestation, mortality locations, and change in stand composition. These data would be used to plan control and salvage operations in this forest type (see 2.01 Forest Inventory Report). Basic population dynamics information should not be neglected, especially at endemic levels. This information is needed to make the simulation models realistic.

B. Title: Management of pests of hardwoods (defoliators, borers, and scales.

1. Management of pests of hardwoods - defoliators.

Objective: Develop a management scheme to minimize the damage and nuisance caused by the hardwood defoliator complex that attacks northeastern forests.

Situation evaluation: Hardwood defoliators such as the gypsy moth, cankerworms, elm spanworm, forest tent caterpillar, oak leaf rollers and tiers, saddled prominent variable oak leaf caterpillar, cherry scallop shell moth, the red-humped oakworm and webworms periodically cause extensive defoliation in the Northeast. In the forest, the defoliation interferes with maximum wood production by the tree. Defoliation is especially bothersome in urban and recreation areas where frass, webbing, and caterpillars interfere with outdoor pursuits. In the forest the nuisance factor is minimal, but the defoliation is believed to weaken the trees and make them susceptible to other organisms such as borers and the shoestring root rot (see 2.03 Forest Diseases report). The degree of defoliation a tree or stand can tolerate before becoming susceptible to these organisms is unknown and seems to be variable. Just what makes one of the defoliators more abundant at one time or another is unknown (see 2.02 Timber Management Report.).

Research approach: Although these insects have been causing defoliation for many years, we still lack considerable knowledge of their life history and ecology. Methods of detection and appraisal (impact assessment) should be stressed along with various combinations of control. Change in stand compositions as a result of defoliation should be considered a part of impact assessment. The interrelationships between the tree, defoliator (insect) and control combination need to be investigated by a team of specialists so that more realistic control decisions can be reached. Interactive computer models may aid this decision-making process.

Life tables, including parasites and predators, some of which are shared by the insect pests, and remote sensing methods would be useful techniques to identify major mortality factors and to monitor the effects of defoliation over time. Innovative control methods that combine various chemical agents and manipulative techniques need to be explored. New, safe chemical agents, biological controls and products of chemical ecology should also be investigated in conjunction with new delivery systems such as time release aerosols.

2. Management of pests of hardwoods - borers.

Objective: Minimize the effect of wood-boring insects on lumber grade yield and value.

Situation evaluation: Wood-boring insects have a significant effect on lumber grade yield and value. A study in Ohio estimated that the red oak borer, the white oak borer, two species of carpenterworms and the oak timberworm cause Ohio woodland owners losses between $2 and $3 million annually. Lumber degrade by borers in the Southeast has been estimated at over $36 million annually. In the northern hardwood region, borer loss figures are not available, but the sugar-maple borer and the maple callus borer cause serious injury to sugar maple that results in lumber degrade. Similarly, the Columbian timber beetle affects soft maple. Valuable black cherry is attacked by a cambium miner, Phytobia pruinosa which results in reduced lumber quality.

Research approach: Practically all these borers have a one to two year life cycle, most of which is spent in the cambium region of living trees. Life history and ecological relationships must be investigated before methods of detection and estimating borer density can be developed. Radiographs for detection in living trees would be useful in the laboratory and field phase of the investigation. Artificial rearing techniques should be investigated for behavioral and physiological studies. Available silvicultural or forest management techniques may be adequate for control of these borers if early detection capabilities are improved. Other means of control (pheromones, attractants, repellants) are more suitable for urban situations. When adequate biological data are available, a team of specialists should develop methods for appraising the impact of these insects on the forest or products.

3. Other pests of the northern hardwood timber type - scales.

Aside from borers and defoliators, several scale insects are potential problems to the northern hardwood forests of the region. Stands of beech appear to be faced with another outbreak of the beech bark disease (scale and fungus). This situation is further complicated by another scale (Xylococculus betulae) and the growing commercial value of beech (see 2.03 Forest Diseases Report).

A localized component of the northern hardwood forest timber type is the conifer hemlock. This valuable species is threatened by the hemlock scale. This introduced scale has been mainly a problem of ornamentalists, but recently it has been discovered in parks and forest settings. The impact of these scales is not known.

C. Title: Management of pests of coniferous plantations.

Objective: Reduce damage caused by insects to planted pine and maximize growth and wood production.

Situation evaluation: Plantations represent a significant investment of time and effort. The costs of producing the seedlings, planting time, and subsequent care tend to increase annually. If site preparation is necessary, the cost of planting becomes even greater and the value of the crop will have to be significant to carry these costs. For instance, a Christmas tree plantation falls into this value category and, in the Northeast, this will probably be the primary role for pine plantations.

For Christmas tree production, these pests must be controlled through chemical and/or ecological methods if the producer is to provide a salable tree for the public. A tree defoliated by a sawfly such as the European pine sawfly or the red-headed pine sawfly, will not be as desirable as one with full foliage. The white-pine weevil and various shoot and tip moths seriously affect the form and shape of trees destined for this market. Stocking could be drastically reduced by root weevils if appropriate chemical or silvicultural methods are not followed.

Forest plantations will come under close scrutiny by cost/benefit analysis. Perhaps, the demand for recreational areas with adequate parking for campers and their vehicles will provide intangible and dollar benefits greater than those derived from a plantation. Economic considerations and long-term planning will play a more significant role in plantation establishment and management.

The amount of land available in the Northeast for forest plantations is already at a minimum as evidenced by the steady decline in acreage being planted each year. This trend is further sustained by phasing out or drastically reducing the output of many Federal or State nurseries in the Region.

The establishment of large areas devoted to a single species has produced many problems for the forest manager and entomologists. Sawflies, weevils, scale insects and shoot and tip moths are but a few of the insects that thrive in these artificial situations created by a planting. Chemical control and some silvicultural or management techniques have been the major means of combating these problems.

Research approach: Regardless of the use of the plantation, adequate technology must be developed to provide a rapid estimate of insect numbers and a prediction of what this means in terms of damage to the tree or plantation. This will require an understanding of the life history of each insect and the damage it causes.

A serious problem that lacks adequate definition and control procedures is the Matsucoccus scale affecting red pine in Connecticut, southeastern New York and northeastern New Jersey. Many red pine plantations have been destroyed by this pest in the past 20 years and fear of future damage prevents replanting or the use of red pine in these and adjacent areas. For the immediate future, environmentally safe control chemicals should be developed.

Concurrently, efforts should be initiated to provide in-depth life history and ecological studies of other insects attacking pine, such as sawflies, terminal and root feeding weevils and the shoot and tip moth. Such studies would provide clues to the techniques that can be used to reduce the damage caused through environmentally acceptable procedures such as pheromones, the virus or silvicultural methods. Ultimately, this information would be incorporated into an integrated control approach.

Forest plantations represent a different objective for the use of the land and a crop that can be tolerant of something less than a perfectly formed tree. However, the same insect pests are involved and information obtained in one situation would be applicable to the other. The relatively large acreages involved in established plantations might make remote sensing techniques feasible for the monitoring and evaluation of these pests on a regional basis (see 2.01 Forest Inventory Report).

The forest setting also presents some unique problems in addition to the biology and ecology of the pests. An interdisciplinary team should examine this problem and set criteria for forest plantation establishment and management. The criteria should detail such items as: (1) the matching of species to site; (2) management objectives; (3) a management plan; (4) procedures for coping with such problems as rodents, insects, diseases, and insufficient stocking. Incorporated in these criteria would be economic guidelines for gauging when the trees should be thinned, treated for insect and disease problems and harvested. Economics would be central to the management plan and when the planting becomes too expensive to maintain, alternative uses for the site would be examined and justified by a cost/benefit analysis.

D. Title: Management of pests of cone, seed, and seedlings.

Objective: Minimize the time for the natural regeneration of forest stands by minimizing the effects of insects on seed crops and seedlings.

Situation evaluation: More intensive forest management and the possibility of seed orchards in the Northeast requires a more intensive look at insects that destroy seeds and new seedlings. For instance, what is the nature of damage by such species as Curculio sp., Conatrachelus sp., Nepticula sp. and various species of Cecidomyidae on hardwood seeds and reproduction? Insects that destroy seeds may be a major cause of the inability of forest managers to obtain adequate reproduction on an area following a cutting designed for regeneration although there has been adequate site preparation and rodent control. The time lost in securing natural regeneration represents a cost that is unlikely to be tolerable in the future if we are to satisfy the country's projected timber demands. Past seed insect work, especially in the South and here, has focused on coniferous seeds, but in the Northeast the majority of the commercial timber land is covered by hardwood seed regeneration insects. Estimates of losses caused by these insects are not yet compiled (see 2.02 Timber Management Report).

Research approach: The insects attacking hardwood seed and new regeneration should be identified and their life histories defined throughout the regions. The impact of each should be assessed and adequate means to predict damage to the seed crop should be developed. The life table approach could be utilized for cones and seeds and the resulting seedlings. This would identify the important factors affecting survival. From this detailed examination, appropriate chemical, management or silvicultural control measures could be specified and impact data accumulated. Radiographic techniques could be used to assess cone damage or seed germination potential. High value timber areas should be defined for the region and initial work restricted to these areas.

E. Title: Management of pests of wood products.

Objective: Reduce losses during processing, storage, and use of wood.

Situation evaluation: Just as insect-caused losses to growth and development can result in a shortfall of timber supplies, these supplies can be further diminished by insects causing the deterioration of wood in processing, storage and use. Ecologically, these inter-relationships between wood and insects constitute simply a continuum of the natural decline process once the life of the tree is terminated and its break-down is accomplished by the insects and microorganisms, frequently acting in consort. Key factors, both during the life of the tree and subsequently when wood is influenced by its surroundings, need to be determined and elucidated for the importance of the wood and insect associations.

Host woods and related insects are many, and depending upon the problem, may be of varying importance. Chiefly involved with wood in storage and use, high priority candidates for research are the subterranean termites, principally Reticulitermes flavipes; the powder-post beetles, principally of the families Lyctidae (Lyctus planicollis), Anobiidae (Ptilinus ruficornis, Hadrobregmus carinatus and others); Cerambycidae (Hylotrupes bajulus); the carpenter ants, principally Camponotus hurculeanus; and carpenter bees Xylocopa virginica. Insects related to wood being processed include the Scolytidae or ambrosia and bark beetles, particularly Monarthrum mali in hardwoods, Gnathotrichus materiaruis in softwoods and Leperisinus aculeatus in ash; and Cerambycidae, such as Monochamus spp.

At the present time, the control of these insects is made considerably more difficult because of Federal and state restrictions placed upon the chemicals used to control them. Although they are the basis of a multi-million dollar pest control industry, in many cases, the species are considered of such minor importance that they are being ignored by the pesticides manufacturers since registration authorizing chemicals for specific insects is too tedious, difficult and expensive to warrant attention. Therefore, it is most timely and important that a research program to inventory existing knowledge and to acquire new biological and ecological data to enhance preventive measures to be undertaken and control methods developed that are environmentally acceptable.

Research approach: Under the leadership of an ecologically oriented entomologist and with interdisciplinary cooperation of chemists, toxicologists, a prevention and control strategy should be developed. Careful investigations are needed to determine the important factors to the life of these insects, beginning with the chemical constituents of host woods, when these are important to the insects' diet; the time of

harvesting as it affects nutritional value of the host; and any related questions such as the dietary needs of the insects chosen for study. physical factors required for the life of the insects such as temperature, including diapause requirements, humidity and moisture, etc., need to be defined. These insects would also be prime candidates for attractancy studies, both primary and insect-produced secondaries (pheromones, kairomones), chemosterilants and juvenile hormone analogues as new tactics that can be developed to formulate acceptable integrated control strategies.

F. Title: Management of tree diseases transmitted by insect vectors.

Objective: Utilize current and new information to reduce the losses caused by insect vectored tree diseases; develop, evaluate and refine new methods to detect and control the vectors or pathogens in urban and rural areas at an acceptable cost.

Situation evaluation: Bark beetles are believed to be the major vectors of Dutch elm diseases and oak wilt, while leaf hoppers are vectors of elm phloem necrosis and possibly other mycoplasma diseases such as black locust witches broom and the bunch diseases of walnut and pecan. Other diseases pathogens, as in the beech bark disease, gain entry into the tree through tiny ruptures in the bark caused by the feeding of the beech scale. Other tree maladies may be vectored by insects also. The loss attributed to Dutch elm disease in cities and oak wilt in the forest have been documented in the literature. We may tend to think of these diseases as primarily urban or shade tree problems. However, with the intensification of forestry in the future and the environmentalists' concern for parks and woodlots within or near major metropolitan centers, the losses caused by insect vectored diseases become more significant.

Current research on the Dutch elm disease is concerned with the bark beetle pheromone. This work utilizes the pheromone for detection and control by attracting the beetles to traps. Also, the use of fungicides to prevent or retard the pathogen of the Dutch elm disease or oak wilt is being investigated (see 2.03 Forest Diseases report).

Research approach: Future research should be interdisciplinary and aimed at obtaining detailed biological information on all vectors, the pathogens and the trees' reaction to the infections. Such information would be basic to corrective or control methods and for developing methods to measure, evaluate and predict vector-pathogen relationships with the tree. Early detection of the vectors or diseased trees should be addressed through pheromones or pre-visual tree symptoms. The use of pheromones should be refined to determine effective trap layout, etc., and under what conditions pheromones might be used along with other methods such as sanitation and chemicals for control of the vectors. Recent research has demonstrated that tetracycline antibiotics are effective in causing remission of symptoms in a number of mycoplasma diseases. In other cases, heat treatment of diseased scion wood used in vegetative propagation has resulted in destroying the mycoplasma pathogen. This approach should be pursued in research aimed at controlling similar mycoplasma type diseases in valuable native tree species. Cost/benefit data should be acquired through appropriate field tests.

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